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10/585,638	01/04/2007	Hideo Ohno	293408US2X PCT	8527
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EXAMINER				
HAN, JONATHAN				
ART UNIT		PAPER NUMBER		
4176				
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary

Application No.

10/585,638

Applicant(s)

OHNO ET AL.

Examiner

JONATHAN HAN

Art Unit

4176

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 January 2007.
2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
4a) Of the above claim(s) _____ is/are withdrawn from consideration.
5) ☐ Claim(s) _____ is/are allowed.
6) ☒ Claim(s) 1-20 is/are rejected.
7) ☐ Claim(s) _____ is/are objected to.
8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
10) ☒ The drawing(s) filed on 07/11/2006 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/CIS)
Paper No(s)/Mail Date 07/11/2006
4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____

DETAILED ACTION

This Office Action is responsive to the Applicant's communication filed 1/04/2007. In virtue of this communication, claims 1-20 are pending in the instant application.

Priority

1. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Claim Objections

2. Claim 8 is objected to because of the following informalities:

- Claim 8, line 6, "the" should be changed to "an" ;

.Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was

not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1-3, 10, 14, and 17-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Flatte et al. (U.S. Publication No. 2003/0209770 A1; hereinafter referred to as "Flatte") in view of Zhu et al. (U.S. Patent No. 5,768,181; hereinafter referred to as "Zhu 1").

With respect to claim 1, Flatte discloses in Figure 3, a current injection-type magnetic domain wall-motion device comprising a microjunction structure [300] including a first magnetic body [301], a second magnetic body [305] and a third magnetic body [303] sandwiched therebetween, wherein the magnetization direction of the device is controlled in such a manner that a current is applied across microjunction interfaces present in the microjunction structure such that a magnetic domain wall is moved by the interaction between the magnetic domain wall and the current in the same direction as that of the current or in the direction opposite to that of the current (see Page 7, Paragraph [0083]).

Flatte does not disclose a second magnetic body with a magnetization direction antiparallel to that of the first magnetic body.

Zhu 1 discloses a second magnetic body with a magnetization direction antiparallel to that of the first magnetic body (see Column 5, lines 28-45).

It would have been obvious to one of ordinary skill in the art at the time of invention to modify the device of Flatte by replacing the parallel magnetic vector of

Flatte with an antiparallel magnetic vector as taught by Zhu 1 for lowering the power consumption in the system (see Zhu 1; Column 5, line 10-15).

With respect to claims 2-3, the combination of Flatte and Zhu 1 discloses all subject matter of claim 1 and further discloses the magnetic bodies are made of a magnetic semiconductor (see Flatte; Page 2, Paragraph [0025]) wherein the magnetic semiconductor is a (Ga, Mn)As ferromagnetic semiconductor (see Flatte; Page 3, Paragraph [0034]).

With respect to claim 10, the combination of Flatte and Zhu 1 discloses all subject material of claim 1, and further discloses the first and second magnetic bodies are made of the same material and the second magnetic body is magnetically coupled with an antiferromagnetic film disposed on the second magnetic body such that the first and second magnetic bodies have different coercive forces (see Zhu 1, Column 5, lines 4-15).

With respect to claim 14, the combination of Flatte and Zhu 1 discloses all subject matter of claim 1 and further discloses the third magnetic body has a reduced cross-sectional area such that a magnetic domain wall is encouraged to position at a junction interface between the first and third magnetic bodies or between the second and third magnetic bodies (see Flatte, Page 9, Paragraph [0093]), the magnetic domain wall being present between the first and second magnetic bodies because of the antiparallel magnetization directions of the first and second magnetic bodies, whereby the energy loss due to the creation of the magnetic domain wall in the third magnetic body is less than both that in the first magnetic body and that in the second magnetic

body (see Zhu 1, Column 3, lines 24-39).

With respect to claim 17, the combination of Flatte and Zhu 1 discloses all subject matter of claim 1 and further discloses the first and third magnetic bodies have a constriction at a junction interface therebetween and the second and third magnetic bodies have a constriction at a junction interface therebetween such that a magnetic domain wall is encouraged to be trapped at one of the constrictions and is therefore encouraged to be positioned at a junction between the first and third magnetic bodies or between the second and third magnetic bodies, the magnetic domain wall being present between the first and second magnetic bodies because of the antiparallel magnetization directions of the first and second magnetic bodies (see Zhu 1, Column 3, lines 59-66).

With respect to claim 18-20, the combination of Flatte and Zhu 1 discloses all subject matter of claim 1 and further discloses the magnetization direction of the device can be read out (see Zhu 1, Column 6, lines 58-65), wherein the magnetization state of the third magnetic body is read out in such a manner that the resistance of the element is measured by applying a small current that is insufficient to move the magnetic domain wall, to a current injection terminal using a feature that the device has different resistances depending whether the magnetic domain wall is located at an interface between the first and third magnetic bodies or located at an interface between the second and third magnetic bodies (see Zhu 1, Column 6, lines 58-67), wherein the junction between the first and third magnetic bodies and the junction between the second and third magnetic bodies are formed to have asymmetric structure such that a

difference in resistance is readily created in the device (see Zhu 1, Column 3 line 65-Column 4 line 5).

6. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Flatte et al. (U.S. Publication No. 2003/0209770 A1; hereinafter referred to as "Flatte") in view of Zhu et al. (U.S. Patent No. 5,768,181; hereinafter referred to as "Zhu 1") as applied to claims 1 and 2 above, and further in view of Chang et al. (U.S. Patent No. 5,294,287; hereinafter referred to as "Chang").

With respect to claim 4, the combination of Flatte and Zhu 1 discloses all subject matter of claim 2 except for specifying that the magnetic semiconductor is an (In, Mn)As ferromagnetic semiconductor.

Chang discloses the magnetic semiconductor is an (In, Mn)As ferromagnetic semiconductor (see Column 8, lines 10-18).

It would have been obvious to one of ordinary skill in the art at the time of invention to employ an (In, Mn)As ferromagnetic semiconductor in the combination of Flatte and Zhu 1, in order to produce the three magnetic semiconductor bodies that would result in the desired magnetic ordering and electronic conduction (see Chang Column 6, lines 38-44).

7. Claims 5, 11, 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Flatte et al. (U.S. Publication No. 2003/0209770 A1; hereinafter referred to as Flatte) in view of Zhu et al. (U.S. Patent No. 5,768,181; hereinafter "Zhu 1") as applied to claims 1-

2 above, further in view of Chang et al. (U.S. Patent No. 5,294,287; hereinafter referred to as "Chang") as applied to claims 1-4 above, and further in view of Wang et al. (U.S. Patent No. 6,713,195 B2; hereinafter referred to as "Wang")

With respect to claim 5, the combination of Flatte and Zhu and Chang disclose all the claim limitations of claims 1-4 except for specifying that the current is a pulse current.

Wang discloses the current is a pulse current (see Column 11, lines 28-33).

It would have been obvious to one of ordinary skill in the art at the time of invention to employ a pulse current as taught by Wang in the device as disclosed by the combination of Flatte, Zhu1, and Chang in lieu of a steady current for lowering the power consumption (see Wang Column 11, lines 28-33), and thus the domain wall positioning via electrical induction becomes more efficient.

With respect to claims 11 and 13, the combination of Flatte, Zhu 1 and Chang discloses all subject matter of claims 1-4 except for specifying that the first and second magnetic bodies are made of the same material, and have different film thicknesses, such that the first and second magnetic bodies have different coercive forces and different external electric fields are applied to the first and second magnetic bodies made of magnetic semiconductor, such that the first and second magnetic bodies have different coercive forces.

Wang discloses the first and second magnetic bodies are made of the same material, and have different film thicknesses, such that the first and second magnetic bodies have different coercive forces (see Column 5, lines 3-14) and different external

electric fields are applied to the first and second magnetic bodies made of magnetic semiconductor, such that the first and second magnetic bodies have different coercive forces (see Column 5, lines 50-57).

It would have been obvious to one of ordinary skill in the art at the time of invention to modify the thickness of the device as disclosed by the combination of Flatte, Zhu 1, and Chang to vary the switching thresholds for each of the outside composite layers while in a magnetic field as taught by Wang to allow for better control of the ferromagnetic layers in response to an externally applied operating magnetic or electrical field (see Wang; Column 5, lines 10-14 and 50-57).

8. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Flatte et al. (U.S. Publication No. 2003/0209770 A1; hereinafter referred to as "Flatte") in view of Zhu et al. (U.S. Patent No. 5,768,181; hereinafter referred to as "Zhu 1") as applied to claims 1-2 above, further in view of Chang et al. (U.S. Patent No. 5,294,287; hereinafter referred to as "Chang") as applied to claims 1-4 above, further in view of Wang et al. (U.S. Patent No. 6,713,195 B2; hereinafter referred to as "Wang") as applied to claims 1-5 above, and further in view of Grollier (Grollier, February 2003).

With respect to claim 6, the combination of Flatte, Zhu 1, Chang, and Wang discloses all subject matter of claims 1-5. The combination does not disclose the pulse current has a current density of 10^4 - 10^7 A/cm².

Grollier discloses the pulse current has a current density of the order of 10^6 A/cm² and there is some uncertainty in the exact value of the current density (see Grollier, Page 510, Paragraph 2).

While Grollier does not explicitly disclose the range of the pulse current has a current density of 10^4 - 10^7 A/cm², it has been held that where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to implement the proper current density during the implementation of the device as disclosed by the combination of Flatte, Zhu 1, Chang and Wang, resulting in a displacement of the domain wall (see Grollier, Page 510, Paragraph 2)

9. Claims 7-9 and 15-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Flatte et al. (U.S. Publication No. 2003/0209770 A1; hereinafter referred to as "Flatte") and Zhu et al. (U.S. Patent No. 5,768,181; hereinafter referred to as "Zhu 1") as applied to claim 1 above, and further in view of Zhu et al. (U.S. Patent No. 5,734,605; hereinafter referred to as "Zhu 2").

With respect to claims 7-8, the combination of Flatte and Zhu 1 discloses all subject matter of claim 1 and further discloses the first magnetic body and the second magnetic body with a magnetization direction antiparallel to that of the first magnetic body are prepared (see Zhu 1, Column 3, lines 41-58) and wherein the magnetization directions of the first and second magnetic bodies are aligned antiparallel to each other with an external magnetic field using a difference in coercive force therebetween after the film formation (see Zhu 1, Column 5, lines 16-27).

The combination does not disclose the first magnetic body and the second magnetic body prepared by film formation in a magnetic field.

Zhu 2 discloses the first magnetic body and the second magnetic body are prepared by film formation in a magnetic field (see Column 5, lines 6-9, and Column 5 line 60- Column 6 line 5.)

It would have been obvious to one of ordinary skill in the art at the time of invention to employ a magnetic field as disclosed in Zhu 2 during film formation of the device disclosed by the combination of Flatte and Zhu 1 to switch the system from a parallel to an anti-parallel magnetization (see Zhu 2, Column 6, line 65 -55).

With respect to claim 9, the combination of Flatte, Zhu 1, and Zhu 2 discloses all subject material of claims 1 and 8 and further discloses the first and second magnetic bodies are made of different materials (see Zhu 2, Column 4, lines 8-15).

With respect to claim 15, the combination of Flatte and Zhu 1 discloses all subject matter of claim 1 and further discloses the magnetic domain wall being present between the first and second magnetic bodies because of the antiparallel magnetization directions of the first and second magnetic bodies, whereby the energy loss due to the creation of the magnetic domain wall in the third magnetic body is less than both that in the first magnetic body and that in the second magnetic body (see Zhu 1, Column 5, lines 4-15).

The combination does not disclose wherein the third magnetic body is made of a material with a magnetization smaller than that of a material for forming the first and second magnetic body such that a magnetic domain wall is encouraged to position at a junction interface between the first and third magnetic bodies or between the second and third magnetic bodies.

Zhu 2 discloses the third magnetic body is made of a material with a magnetization smaller than that of a material for forming the first and second magnetic body such that a magnetic domain wall is encouraged to position at a junction interface between the first and third magnetic bodies or between the second and third magnetic bodies (see Column 5, lines 3-9).

It would have been obvious to one of ordinary skill in the art at the time of invention to modify the device of the combination of Flatte and Zhu 1 by adding an intermediate layer with a smaller magnetization to encourage domain wall positioning based on different magnetizations as taught by Zhu 2 to lower the energy consumption of positioning the domain wall (see Column 5, lines 3-9).

With respect to claim 16, the combination of Flatte and Zhu 1 discloses all subject matter of claim 1 and further discloses wherein the first to third magnetic bodies are made of the same material and the magnetic domain wall being present between the first and second magnetic bodies because of the antiparallel magnetization directions of the first and second magnetic bodies, whereby the energy loss due to the creation of the magnetic domain wall in the third magnetic body is less than both that in the first magnetic body and that in the second magnetic body (see Zhu 1, Column 5, lines 4-15).

The combination does not disclose the magnetization of the third magnetic body is rendered smaller than both that of the first magnetic body and that of the second magnetic body by applying an external electric field to the third magnetic body such that a magnetic domain wall is encouraged to position at a junction interface between the

first and third magnetic bodies or between the second and third magnetic bodies.

Zhu 2 discloses the magnetization of the third magnetic body is rendered smaller than both that of the first magnetic body and that of the second magnetic body by applying an external electric field to the third magnetic body such that a magnetic domain wall is encouraged to position at a junction interface between the first and third magnetic bodies or between the second and third magnetic bodies (see Column 5, lines 3-9 and Column 6, line 62 – Column 7, line 5).

It would have been obvious to one of ordinary skill in the art at the time of invention to render the intermediate layer of the device of the combination of Flatte and Zhu 1 to be smaller magnetically than the outside layers as taught by Zhu 2 to result in a more controllable positioning of domain walls through electrical dominance of the outside structures (see Flatte page 7, Paragraph [0080] - [0083]).

10. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Flatte et al. (U.S. Publication No. 2003/0209770 A1; hereinafter referred to as "Flatte") and Zhu et al. (U.S. Patent No. 5,768,181; hereinafter referred to as "Zhu 1") as applied to claims 1 above, and further in view of Wang et al. (U.S. Patent No. 6,713,195 B2; hereinafter referred to as "Wang").

With respect to claim 12, the combination of Flatte and Zhu 1 discloses all subject material of claims 1 but does not specify that the first and second magnetic bodies are made of the same material, and have different shapes, such that the first and second magnetic bodies have different coercive forces due to difference of shape anisotropy.

Wang discloses the first and second magnetic bodies are made of the same material, and have different shapes and the first and second magnetic bodies have different coercive forces due to difference of shape anisotropy (see Column 5, lines 10-25; modifying the thickness modifies shape of the structure).

It would have been obvious to one of ordinary skill in the art to modify the device of the combination of Flatte and Zhu 1 by changing the shape of the ferromagnetic structures to modify the shape anisotropy as taught by Wang to modify the coercive force on the magnetic layers that gives the thicker ferromagnetic layer a magnetization which is fixed in orientation (see Wang Column 5, lines 17-23).

Citation of Prior Art

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- Sato et al. (U.S. Publication No. 2001/0007532 A1) discloses trilayer ferromagnetic element with changeable magnetized direction.

- Mao et al. (U.S. Patent No. 6,456,467) discloses a thin film structure used for shielding a transducing head containing multiple ferromagnetic layering with antiparallel magnetization.

- Nakatani et al. (U.S. Patent No. 5,390,061) discloses a magnetoresistance element with multiple semiconductor and antiferromagnetic materials.

- Hempstead et al. (U.S. Patent No. 4,106,315) discloses a thin film magnetic

transducer with ferromagnetic materials and antiferromagnetic material deposited on one another.

Inquiry

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JONATHAN HAN whose telephone number is (571)270-7546. The examiner can normally be reached on Monday Through Friday 7:30 AM -5 PM EST, Alternate Fridays Off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thuy V. Tran can be reached on (571)272-1828. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JONATHAN HAN/

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Examiner, Art Unit 4176

/Thuy Vinh Tran/

Supervisory Patent Examiner, Art Unit 4176